AUSTEMPERING LOW ALLOY STEEL (20X1MΦA) BY USED MOLTEN COPPER

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Abstract

We examined and study the characteristics properties of bainitic low alloy steel (20X1MΦA) obtained by used molten copper Instead what is customary in this process using molten salts. X-ray diffractometry (XRD) and optical microscopy (OM) were used to characterize their crystal structures, microstructure and micro hardness.

Introduction

The use of molten metal's as quenching media decreased greatly in recent years, largely due to the availability of salts, which are cheaper and provide more flexibility as quenching agents. Molting lead is still used to a limited extent, but in the zone very limited in addition to the risk of toxicity resulting from emissions from furnaces to humans make of this heat treatment is very limited [1]. Molten lead often has been used as quenchant for patenting, as a mill process for heat treating steel wire. Lead also has been used to some extent for austempering, where its working range is compatible with the specific steel being processed. Austempering is a process wherein the steel is austenitized ,then quenched to some temperature below the nose of the TTT curve ,buy above the Ms temperature ,and allowed to transform isothermally to bainite over a period of time. The time and temperature depend on the transformation characteristics of the steel being processed. Low alloy (20X1MΦA) steel is well suited to austempering, as indicated by the TTT curve shown in the fig.1. Selection of steel for austempering must be based on transformation characteristics as indicated in time-temperature-transformation diagrams.

Three important considerations are (a) the location of the nose of the TTT curve and the time available for bypassing it, (b) the time required for complete transformation of austenite to bainite at the austempering temperature, and (c) the location of the MS point.

Materials and Experimental Procedures

Annealed Low alloy steel (20X1MΦA) sample with a (10x10x50) mm were used in this study chemical composition as shown in table 1.

Table1.

Composition of low alloy steel (20X1MΦA)(wt.%).

C	Cr	Mo	V	Mn	Si	Ni	Ca	Al	N_2	P	S
0.2	1.3	0.41	0.081	0.58	0.25	0.1	0.0026	0.026	0.162	0.008	0.003

Sample of low alloy steel has been putting in a small container with powder of pure copper 99.99% in a vacuum furnace to temperature 1200^{o}C for 1.5 hours and cooled slowly to 1000^{o}C in 0,5 hour and quenched in air rapidly. After reached at room temperature we were don the second step of heat treatment (austempering), by heated the sample at austenitic temperature 890^{o}C for 30 min and quenched at the second furnace at 600^{o}C for 1.5 hour then cooled at the room temperature. Cutting the sample 2 half to inspection the surface after cleaned it.

Result and Discussion

Hardness and micro hardness

We examined hardness and micro hardness of the part which copper rounded and the part without copper to compare the difference between them. The results shown in table 2.

Table 2.

Hardness test HRC. Steel in molten Cu and without Cu.

St + Cu	St. without Cu
36.5	22.5
39	23
41.2	24
38	22
40	26
39	24

Micro hardness results shown in Table3.

Table 3.

Micro hardness test HV. Steel in molten Cu and without Cu.

St + Cu	St. without Cu
406.6	291.5
460.6	358.8
430.5	334.2
462.6	299.8
441.5	3.5.5
439.3	289.9

The effect of cooling rate and copper used in this new austempering on the microstructure obtained show clearly in the figures 1.

Conclusions

This research was a first attempt to study and Knowledge the changes and improvement of the mechanical properties of low alloy steel which is used as small parts in sensitive field requiring very high hardness and homogeneity to get to the better performance. Results that have been mentioned previously give a clear vision about the importance of copper in improving properties of bainite compared with the classic way by used salt furnace. So copper diffusion in the steel with high temperature give good element to obtained constant temperature and homogeneity of bainite with high tensile strength and hardness and high grid of elongation.

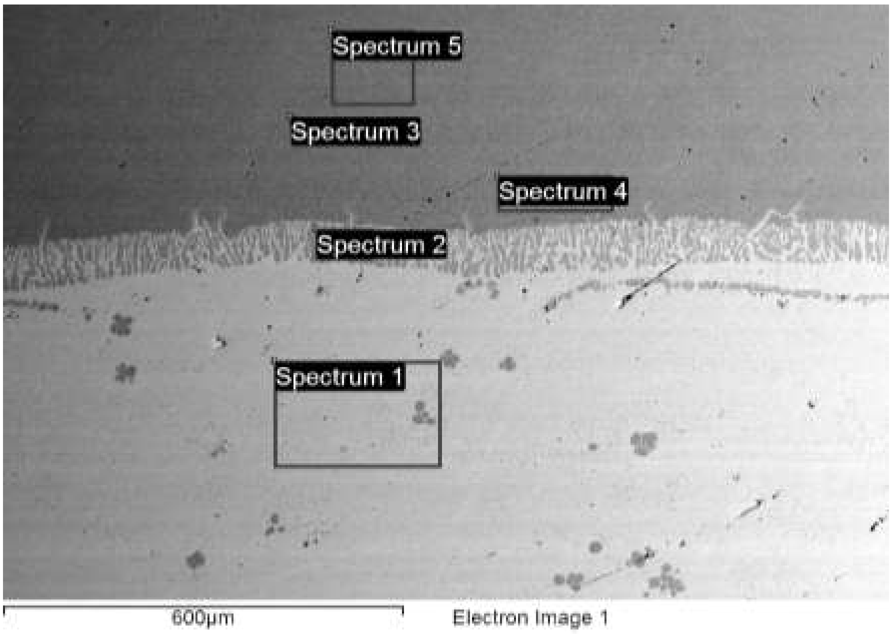
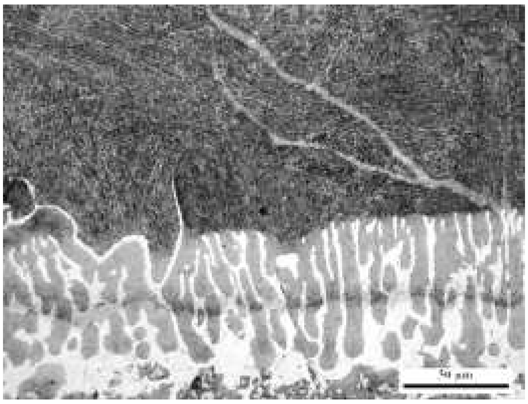


Fig.1 Microstructure. Dark- the copper zone and light- steel austemperd

Table 4.

Chemical composition of points 1,2,3,4,5 Fig.1.

	Si	V	Cr	Mn	Fe	Cu	Mo
Spectrum 1	-	-	-	-	3.8	96.2	-
Spectrum 2	-	0.3	1.0	-	51.7	45.4	1.7
Spectrum 3	-	0.3	1.8	0.6	96.7	-	0.6
Spectrum 4	0.3	-	1.7	0.5	97.5	-	-
Spectrum 5	0.3	-	1.8	0.7	97.3	-	-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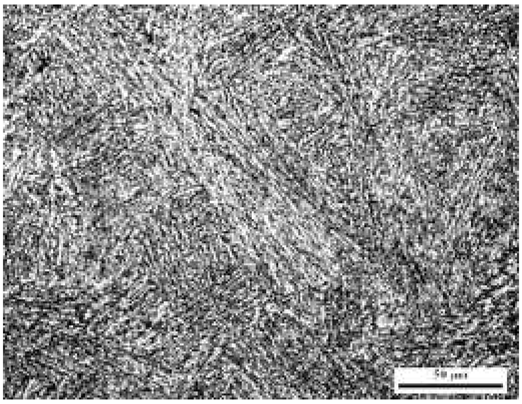
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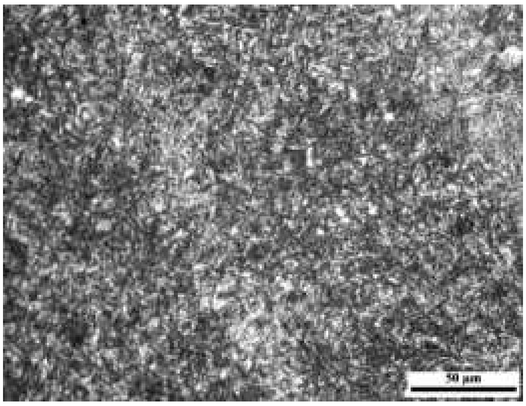
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Fig.3 Microstructure of sample, A- bainite with molten cu, B- Homogeneous bainite, C- Unhomogeneous bainite by classic method (salt furnace).

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